POST-REMEDIAL RADIOLOGICAL DOSE AND RISK ASSESSMENT FOR THE BLISS & LAUGHLIN SITE BUFFALO, NEW YORK

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U. S. Army Corps of Engineers, Buffalo District

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Acronyms

AEC	Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
DOE	U.S. Department of Energy
MED	Manhattan Engineering District
NRC	U.S. Nuclear Regulatory Commission
RESRAD	Residual Radioactivity
ROD	Record of Decision
TEDE	Total Effective Dose Equivalent
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

1 INTRODUCTION

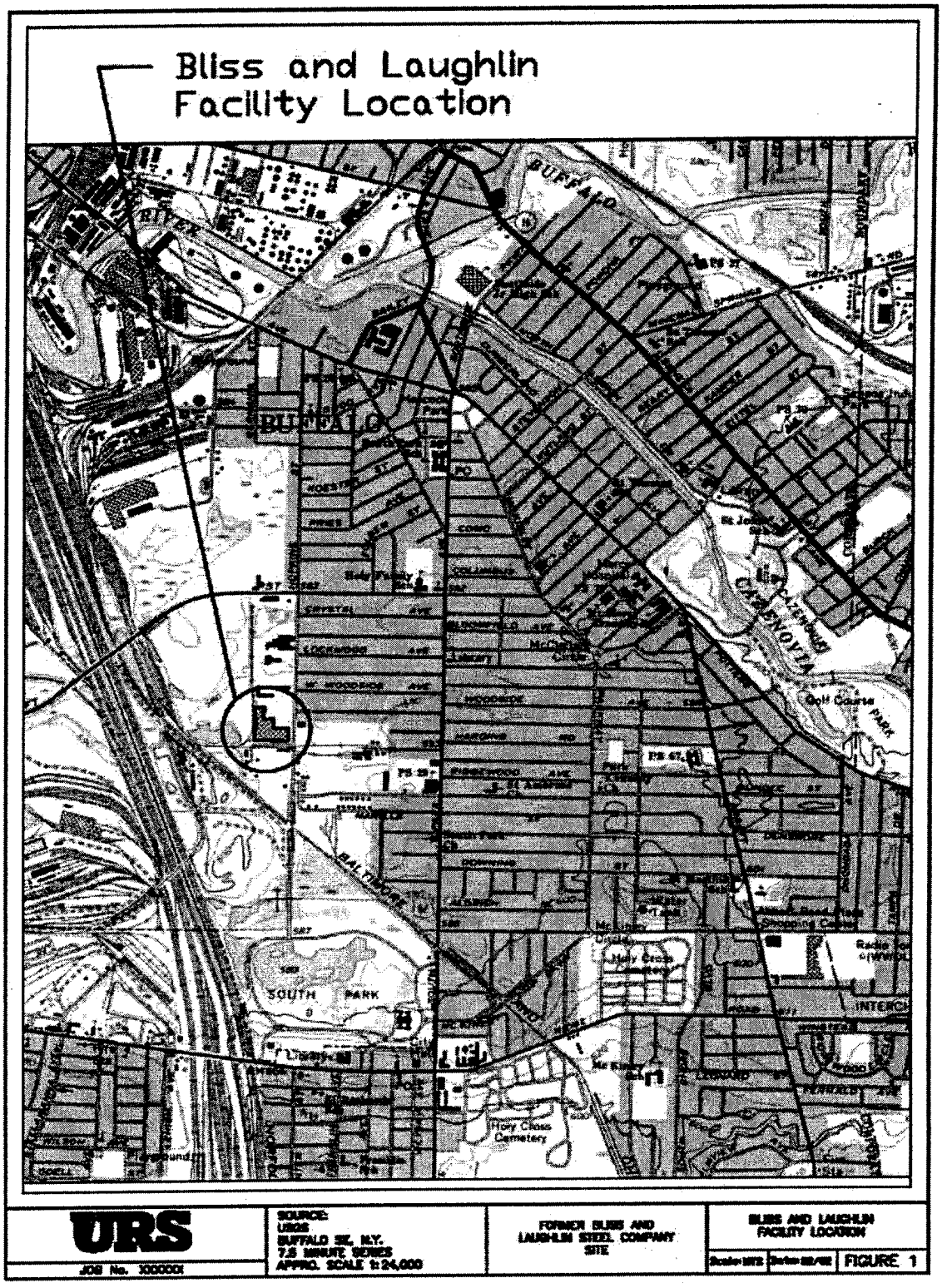
Radiological dose and risk assessments were performed for the Bliss & Laughlin site in order to determine the potential dose and risk due to residual radioactive materials from work conducted under contract to the Manhattan Engineer District (MED). The U.S. Army Corps of Engineers (USACE) determined that Subpart E of 10 CFR 20 is relevant and appropriate in considering the remediation of the Bliss & Laughlin Site. Under these criteria, a site is considered acceptable for unrestricted use if the residual activity that is distinguishable above background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem/y and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). To assure compliance with the selected ARAR (10 CFR 20 Subpart E), two post-remedial dose assessments were performed for the Bliss & Laughlin Site. The first assessed the dose and radiological cancer risk to a resident (subsistence) farmer located on the site, (assuming the buildings would be removed and the property redeveloped in the future), and the other determined the dose and risk to a worker in the facility. These assessments were developed using the U.S. Department of Energy (DOE) RESRAD computer code version 6.1 and RESRAD-Build version 3.1. The details of the assessments are presented in subsequent text.

1.1 SITE DESCRIPTION AND HISTORY

Bliss & Laughlin is located at 110 Hopkins Street, Buffalo, New York. The location of the site is shown in Figure 1. The site consists of a single building with a floor area of about 12,000 m^2 surrounded by approximately 15,000 m^2 of grounds. The plot plan is shown in Figure 2. In 1952, Bliss & Laughlin Steel Company performed machining and straightening operations on uranium rods for National Lead Company of Ohio, a prime contractor for the Atomic Energy Commission (AEC). The site, now owned by Niagara LaSalle Cold Drawn Corporation, is currently used for the forming of steel products and is an active industrial site with equipment such as rolling mills.

Historical records indicate that machining operations involving uranium rods were performed in a section of the building called the "Special Finishing Area," which

occupies a nominal 300 square meters of floor space. The floor of the special finishing area is concrete and contains shallow utility trenches. There are no floor drains. The floor surfaces are generally rough and pitted and are covered with a thin layer of oil absorbent material and dried oil and grease. Machining and material storage racks are present in various areas of the floor. The ceiling is approximately 12 meters high and is supported by a framework of steel trusses. The machining area of the building does not have any interior walls or partitions.


Bliss and Laughlin
Facility Location
BUFFALO
SOUTH PARK
Holy Cross Cemetery
Golf Course
URS
JOB No. XXXXXX
SOURCE:
USGS
BUFFALO SE, N.Y.
7.5 MINUTE SERIES
APPRO. SCALE 1:24,000
FORMER BLISS AND LAUGHLIN STEEL COMPANY SITE
BLISS AND LAUGHLIN FACILITY LOCATION
FIGURE 1

Initial surveys indicated elevated concentrations and activities of uranium within the flooring, trenches and pit. Remediation activities included scabbling of the concrete floors and removal of concrete and contaminated soils in the trenches and pit. Trusses were decontaminated by scraping, wiping with maselin and vacuuming using a high-efficiency particulate air vacuum to remove the dust from the trusses as well as other horizontal surfaces. Radionuclide activities in the surface soils and concrete were monitored during the remediation process to discern when remediation was adequate. The soil clean-up standards developed in the Technical Memorandum, *Cleanup Goals for the Soil at the Finishing Area of the Former Bliss and Laughlin Facility* (USACE 1998), were established for the likely future use considering an industrial worker and a construction worker who have limited occupancy at the site, but are also protective for a residential scenario.

1.2 PURPOSE

The post-remedial assessments were performed to confirm that radiological doses from residual radioactivity associated with MED activities will not exceed the criteria established in the Record of Decision (ROD) for unrestricted release of the facility. In addition, the results of the assessments were compared to guidance including the U. S. Environmental Protection Agency (USEPA) guidance for a maximum 15 mrem/y, consistent with the range of allowable risk for CERCLA remedies, and the New York State guidance of 10 mrem/y (TAGM-4003) to the maximally-exposed individual.

The assumptions used to develop the models to assess the dose are described in Section 2. The calculation methods and the results are presented in Sections 3 and 4, respectively. Conclusions are presented in Section 5 and a list of references is included. The selected pathways, survey results, the input parameters and the output of the RESRAD code are included in the appendices.

2 ASSUMPTIONS

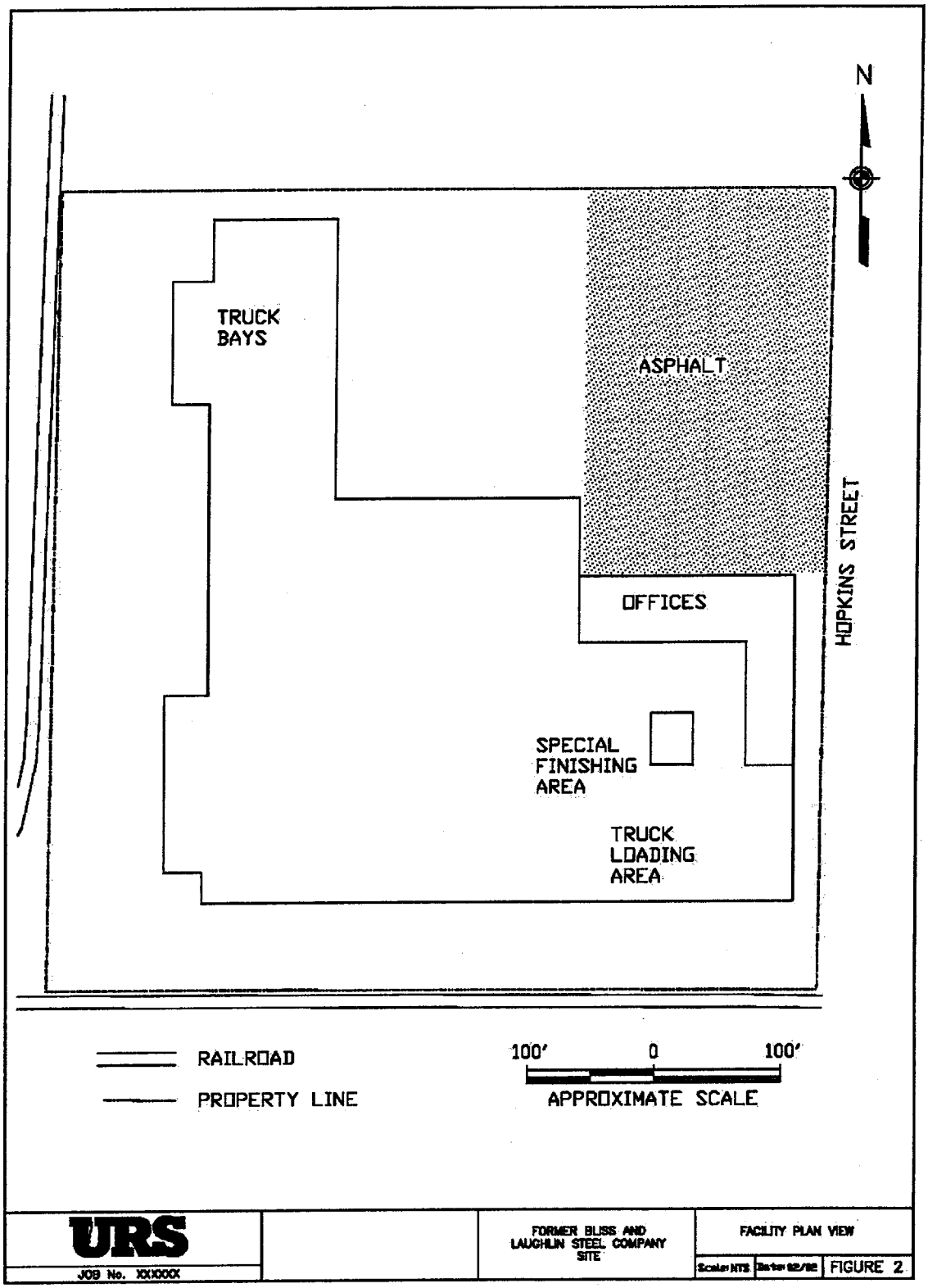
2.1 RESIDENT FARMER

Although the reasonable future land use of the Bliss and Laughlin site would be to remain an industrial facility, the demolition of the buildings and redevelopment of the site as farm land was also considered. In order to determine the radiological dose to the resident farmer, a series of assumptions were made. The scenario that would result in the largest dose to an individual would be when one lives on the site and grows their own food including meat and dairy. This scenario known as the resident (subsistence) farmer scenario, although unlikely, is the most conservative situation to consider. As stated in this scenario, the farmer raises part of their food supply from the site. This includes plant foods, meat, and milk. For this case, the farmer would receive a radiological dose from the crops raised on the property and the animals raised on the site as well as exposure to the ground itself. The crops would be grown in contaminated soil and be irrigated with water from a well located on the site. The livestock would eat the contaminated plants and drink the contaminated water. The farmer would be exposed to direct radiation from the radionuclides in the earth; inhale, as well as ingest, radioactive dust; and be exposed to radon decay products. In the assessment of the Bliss & Laughlin facility, the aquatic pathway was not assessed because there are no fish bearing water bodies within 0.25 miles of the site. Further, the impact of the aquatic foods pathway would be negligible given the size of the zone of contamination. Consistent with the Technical Memorandum, *Cleanup Goals for Soil at the Finishing Area of the Former Bliss & Laughlin Facility, Buffalo, New York* (USACE 1998), the radon pathway was likewise excluded considering that radon standards are based on air concentrations. Also modeling radon migration into structures from soils is highly uncertain. All pathways included in this scenario are listed in Appendix A.

Upon determining the pathways of exposure, the radionuclides and their concentration in the soil were established. From the site history, the only MED material used on the site was natural uranium. Natural uranium consists of 99.3% of U-238 and 0.7% U-235. There are also trace amounts of U-234. The data from the final site survey, shown in Appendix B, was used to develop the concentrations of radionuclides in the soil. The

average concentration in the soil samples was used per the guidance in the RESRAD manual. The concentration in the soil assumed to be homogeneously distributed was modeled as 8.0 pCi/g natural uranium, 3.4, 0.15, and 4.6 pCi/g of U-238, U-235, and U-234, respectively.

The area of the Bliss & Laughlin site is approximately 15,000 m^2. However the only area to process MED material was the Special Finishing Area. As shown in Figure 2, the Special Finishing Area is a small fraction of the total area of the site. This area is 300 m^2, and therefore, the area of contamination modeled using the RESRAD computer code is 300 m^2.



URS		FORMER BLISS AND LAUGHLIN STEEL COMPANY SITE	FACILITY PLAN VIEW
JOB No. XXXXXX			Scale: NTS Date: 02/02 FIGURE 2

The USACE selection of values for RESRAD input parameters for assessing dose and risk at the Bliss & Laughlin site follows this hierachy: (1) site-specific values, (2) values recommended by USEPA, (3) RESRAD defaults. Based upon the *Soil Survey of Erie County New York* done by the United States Department of Agriculture, Soil Conservation Service, December 1986, the area surrounding the Bliss & Laughlin site is Urban Land. This classification is a miscellaneous one in which 80 percent or more of the soil surface is covered by asphalt, concrete, buildings, or other impervious structures. However, immediately adjacent the land is classified as Niagara Silt Loam. This classification is most closely related to silty clay loam. Therefore, the RESRAD parameters relating to soil type were changed appropriately or RESRAD default values were used. In addition, climatic data was obtained from the National Weather Service for the Buffalo area and used in the model. These values as well as all other inputs for the computer code are provided in Appendix C.

2.2 INDUSTRIAL WORKER

In order to determine the radiological dose to the industrial worker, a series of assumptions were made. The scenario that would result in the largest dose to a worker would be when he works in the facility immediately adjacent to the contamination for nine hours a day. The worker would be exposed to several pathways. These pathways are external radiation, deposition of particles on their skin, immersion in a radioactive cloud, inhalation and ingestion of radionuclides. The radon pathway was not assessed, as previously justified. The pathways are listed in Appendix A.

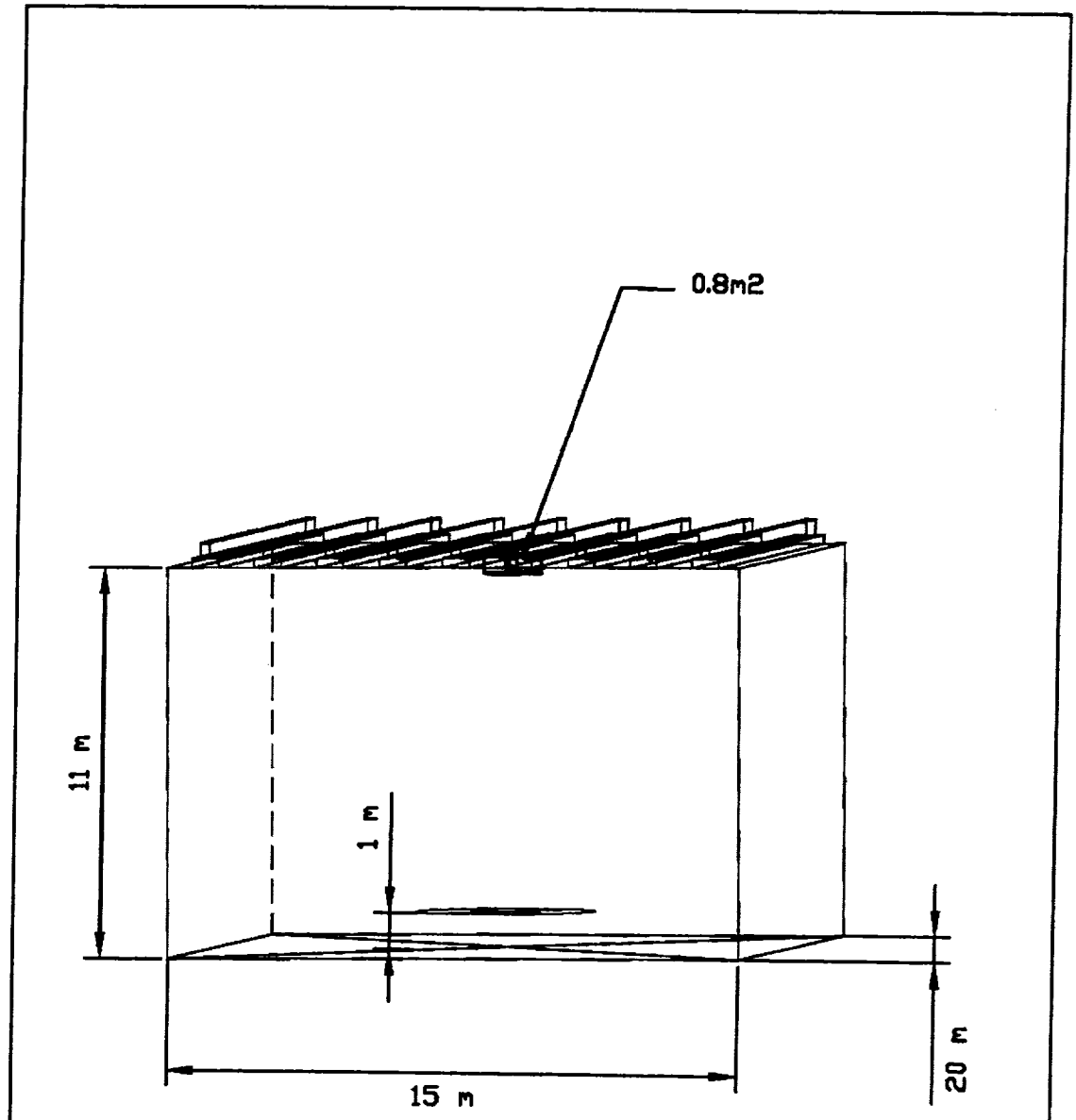
In reviewing the Final Status Survey Report, two areas of contamination were identified to include in the RESRAD-Build model. The first is the contamination of the Special Finishing Area floor. The second is the trusses above this area. The Special Finishing Area is 300 m^2 and there are 16 linear meters of trusses in this area. The total length of the trusses was converted into a respective circular area directly above the receptor. The trusses were assumed to be 8 cm in width and cross members 5 cm, which gives a combined truss area of 2.08 m^2.

Surveys of the trusses and concrete floor were taken during the Final Status Survey, and the average results of the survey showed total alpha contamination of 23.5 dpm/100 cm^2 and 123 dpm/100 cm^2 on the floor and trusses, respectively. The levels of alpha contamination were used since uranium and its progeny are primarily alpha emitters and alpha contamination is usually not found in background measurements. Therefore, any alpha contamination is assumed to be from uranium. The survey results are provided in Appendix B. The RESRAD-Build computer code requires concentrations to be entered in units of square meter. Therefore, the two sources modeled in the computation was an area source on a 300 m^2 with levels of contamination of 2350 dpm/m^2 (U-238 1150, U-235 52.8, and U-234 1150 dpm/m^2). The second source modeled is a contaminated steel plate of 2.08 m^2 having contamination levels of 12,300 dpm/m^2 (U-238 5990, U-235 276, and U-234 6030 dpm/m^2).

To maximize the dose and therefore the risk to the worker, the sources of contamination were modeled as close to the worker as feasible. The worker was assumed to work in the Special Finishing Area and therefore, the source was at his feet. As described earlier, the trusses are conservatively assumed to be one area of contamination. This source was placed directly above the workers head. An illustration is presented in Figure 3.

Another conservative assumption is that the worker spends the entire time working in the Special Finishing Area. This would result in the worker receiving the maximum dose possible. The worker spends 9 hours a day, 250 days a year directly between the sources.

All input parameters for the computer code are provided in Appendix C.



URS		FORMER BLISS AND LAUGHLIN STEEL COMPANY SITE	FINISHING AREA
JOB No. XXXXXX			Scale: NTS Date: 02/02 FIGURE 3

3 METHODS

3.1 RESIDENT FARMER

The computer code RESRAD Version 6.1 was used to model the dose and risk to a future resident farmer exposed to the residual MED materials (natural uranium) in the soils underneath the Special Finishing Area assuming that the site would be redeveloped in the future and the building demolished. The resident farmer is assumed the worst case scenario, if the dose to this hypothetical person meets the dose requirements, then they will be met for all potential uses of the site. In this evaluation, all pathways except for aquatic foods and radon were used in the evaluation. The USACE selection of values for RESRAD input parameters for assessing dose and risk at the Bliss & Laughlin site follows this hierachy: (1) site-specific values, (2) values recommended by USEPA, (3) RESRAD defaults.

3.2 INDUSTRIAL WORKER

The computer code RESRAD-Build Version 3.1 was used to model the dose to a potential industrial worker exposed to the residual MED materials (natural uranium) in the Special Finishing Area. ICRP-60, *Recommendations of the International Commission on Radiological Protections,* dose to latent cancer risk coefficient was used to calculate the risk to a potential industrial worker. The USACE selection of values for RESRAD input parameters for assessing dose and risk at the Bliss & Laughlin site follows this hierachy: (1) site-specific values, (2) RESRAD-Build defaults.

4 RESULTS

4.1 RESIDENT FARMER

Results of the RESRAD model predict that the residential farmer would receive a maximum radiological dose of 1.7 mrem/y 989 years from site release. The model assumes the farm is established on a 300 m^2 site uniformly contaminated with 8.0 pCi/g natural uranium, (3.4, 0.15, and 4.6 pCi/g of U-238, U-235, and U-234 respectively. The resulting total excess cancer risk from this dose is 1.3E-05. The total annual doses and

risks for all years evaluated are shown in Table-1. The results for the dose and risk assessment are provided in Appendix D and E, respectively.

Table 1 Radiological Dose and Associated Risk to a Residential Farmer		
Year	Dose (mrem/y)	Total Excess Cancer Risk
0	0.40	6.0E-06
1	0.40	6.0E-06
3	0.40	6.0E-06
10	0.39	5.8E-06
30	0.36	5.4E-06
100	0.28	4.2E-06
300	0.26	3.8E-06
989	1.7	1.3E-05
1000	1.7	1.3E-05
3000	0.04	3.8E-07
10000	0.05	4.9E-07

4.2 INDUSTRIAL WORKER

Results of the RESRAD-Build Version 3.1 model predict that the industrial worker receives a maximum radiological dose of 0.14 mrem/y in the first year when they work in the Special Finishing Area 9 hours a day for 250 days a year. The dose is from 2 sources, 300 m^2 concrete contaminated with 23.5 dpm/100 cm^2 of natural uranium (U-238 11.5, U-235 0.528, and U-234 11.5 dpm/cm^2) and 2.08 m^2 steel contaminated with 123 dpm/100 cm^2 (U-238 59.9, U-235 2.76, and U-234 60.3 dpm/m^2) of uranium. The worker is assumed to work in the center of both sources. The concrete is at his feet, 1 meter away and the steel is 11 meters from the floor. The resulting risk from this dose is 7E-08 latent cancer fatalities. The radiological doses and resulting risks from both sources and the totals are shown in Table-2. The output from the RESRAD-Build run is given in Appendix D.

Table 2 Radiological Dose and Latent Cancer Risks to an Industrial Worker				
Source	Year 0		Year 1	
	Dose (mrem/y)	Latent Cancer Fatality Risk	Dose (mrem/y)	Latent Cancer Fatality Risk
Concrete	1.4E-01	7E-08	1.4E-04	7E-11
Trusses	4.9E-03	2E-09	9.9E-07	5E-13
Total	1.4E-01	7E-08	1.4E-04	7E-11
*Latent Cancer Risk Factor 5E-07/mrem per ICRP-60				

5 CONCLUSIONS

Based on the results of the modeling, the Bliss & Laughlin site remediation meets the criteria specified in the Record of Decision, including the ARAR of 10 CFR 20 Subpart E which specifies an unrestricted release dose limit of 25 mrem/y. In addition, the site has been remediated to a level which meets the USEPA guidance of 15 mrem/y and the New York State TAGM 4003 guidance of 10 mrem/y. These dose limits/guidance are met for both the residential farmer and industrial worker scenarios.

6 REFERENCES

ANL/EAD-4, Yu, C. et al. *User's Manual for RESRAD Version 6*, Argonne National Laboratory, July, 2001.

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TAGM-4003, *Cleanup Guideline for Soils Contaminated with Radioactive Materials,* New York State Department of Environmental Conservation Division of Hazardous Substances Regulation, September 1993.

Technical Memorandum *Cleanup Goals for the Soil at the Finishing Area of the Former Bliss and Laughlin Facility, Buffalo, New York.* United States Army Corps of Engineers, Buffalo District, December 1998.

7 APPENDIXES

Appendix A Pathways Evaluated

Appendix B Survey Data

Appendix C Parameter Values Used

Appendix D Dose Assessment

APPENDIX A PATHWAYS EVALUATED

A-1 PATHWAYS EVALUATED WITH RESRAD FOR RESIDENT FARMER

External gamma	Assessed
Inhalation (w/o radon)	Assessed
Plant ingestion	Assessed
Meat ingestion	Assessed
Milk ingestion	Assessed
Drinking water	Assessed
Aquatic foods	The aquatic pathway has been turned off because there are no fish bearing water bodies within 0.25 miles of the site. Further, the impact of the aquatic foods pathway would be negligible given the size of the zone of contamination. The closest potentially fish bearing bodies are the Buffalo River, Cazenovia Creek, and South Park Lake.
Soil ingestion	Assessed
Radon	Not included following guidance of the Technical Memorandum, *Cleanup Goals for Soil at the Finishing Area of the Former Bliss and Laughlin Facility, Buffalo, New York*, USACE, December, 1998, it is stated, "The radon pathway was likewise excluded considering that radon standards are based on air concentrations.

A-2 PATHWAYS EVALUATED WITH RESRAD-BUILD FOR INDUSTRIAL WORKER

external radiation	Assessed
deposition of particles on their skin	Assessed
immersion in a radioactive cloud	Assessed
inhalation of radionuclides	Assessed
ingestion of radionuclides	Assessed
exposure to decay of radon progeny	Not Assessed

This Appendix is not available in electronic format.
Contact Wendee Ryan to request a copy.